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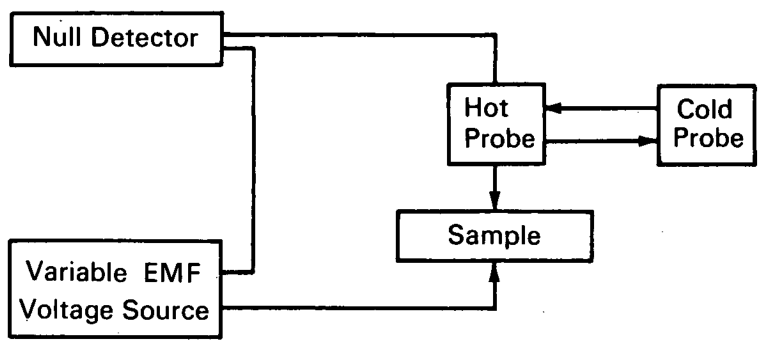
AEC-NASA TECH BRIEF

Thermoelectric Metal Comparator Determines Composition of Alloys and Metals



SIMPLIFIED CIRCUIT OF COMPARATOR

The problem:

To nondestructively inspect unknown metals and alloys for conformance to a chemical specification. A device is required to provide more precise and rapid determination than the spark testing technique, and which produces real numerical values that can be reproduced or recorded for future reference.

The solution:

A device which measures the difference in emf produced by the junction of a hot probe and the junction of a cold contact on the surface of an unknown metal. This instrument utilizes the "Seebeck" (thermal electromotive force) effect, where a hot junction between two dissimilar metals produces a characteristic emf, the magnitude of which is dependent on the temperature of the junction and the composition of the metals.

How it's done:

The emf comparing device consists of a voltage source, a null detector, and hot and cold probes. A temperature controller is used to adjust the proper temperature at the hot probe.

The hot junction is made with a heated iron probe held to the surface of the unknown metal, providing what may be considered an infinite heat source in contact with an infinite heat sink. The required temperature of the hot probe is maintained at $350° \pm 5°$F by the temperature controller, with the controlling thermocouple imbedded in an enlarged section of the hot probe itself. The hot junction lead, which is made from the same material as the hot probe, is imbedded in an Armco iron ring or washer which is in tight contact with the hot probe. The cold junction contact consists of a wire made of the same material as the hot probe and the hot junction lead. It is held in contact with the unknown metal sample by a magnet.

An initial null setting is obtained by placing the hot probe in contact with the cold contact. The temperature of the hot probe is then standardized by taking

(continued overleaf)

sample readings on a known metal, such as SAE 1040 steel, and adjusting the temperature of the probe until a standard emf is obtained. The hot probe and cold contact are then placed on the metal sample to be tested. The hot probe sample junction and the cold contact sample junction each display the "Seebeck" effect. The total emf produces an unbalance in the circuit which is indicated on the null detector. This unbalance is eliminated by adjusting the variable emf voltage source until a null is reestablished. The difference between the initial null emf and the sample null emf is read directly from the voltage source potentiometer. Emf values are read to 1/100 of a millivolt in the range of 0.01 to 10.0 millivolts, with an accuracy of ±1/100 of a millivolt.

Notes:

1. Most commercial ferrous and nonferrous alloys do not have overlapping emf ranges and are easily determined. However, if an alloy to be tested has an overlapping emf range with any other alloy or unalloyed metal being considered, it may be necessary to supplement this device with some other means of determining whether the alloy has a given composition.
2. Inquiries concerning this innovation may be directed to:

   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 South Cass Avenue
   Argonne, Illinois 60439
   Reference: B67-10035

   Source: C. C. Stone and D. E. Walker
   Metallurgy Division
   (ARG-235)

Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

Mr. George H. Lee, Chief
Chicago Patent Group
U.S. Atomic Energy Commission
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois 60439